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TENSILE TEST ON THE MULTI-FASTENER SINGLE-LAP JOINT WITH MISSING BOLT

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ABSTRACT

During experimental work, show the bearing type of failure in the specimens. This failure is depend on the e/d and w/d ratio of the specimen. When e/d and w/d ratio same then bearing type of failure has become and give a more strength. Stress distribution give the idea about the which grade of bolt will be taken in the connection because of at every hole stress distribution is different. Stress distribution is different than the strength of bolt is different. Also find out the joint behaviors from the Stress-Strain and Load-Elongation graph. It gives the idea about the contact between Hole and bolt. We are losing any one bolt then total strength of bolted connection is reduced and sometimes connection will be fail. Reduction of strength due to missing bolt system give the idea about the failure of safe structure and failure give idea about the e/d and w/d ratio.

KEYWORDS: Missing Bolt System, Bolted Connection.

I. INTRODUCTION

Altering The Geometry Of A Joint Will Invariably Alter The Stress And Strain Distributions Within The Bolted Connection With Missing Bolt System. These Differences Have A Profound Effect On The Stress Concentrations And Consequently The Load-Capacity Of The Joint. It Is Therefore Important To Appreciate The Consequences Of Changing Geometric And Material Parameters. It Oder To Predict Failure Loads, A Criterion Is Needed That Will Define When A Critical Level Of Stress Or Strain Is Reached In The Rupture.

This Failure (or Yield) Criterion Can Be Used, In Conjunction With Calculated Stress and Strain Distributions Within the Critical Regions of the Joint, to Predict the Onset and Progression of Failure of the Joint. This Report Presents the Results of a Parametric Study That Was Carried Out to evaluate the ability of Commonly Used Failure Criteria for Predicting the Static Strength of Joint with Missing Bolt. Statistical analysis (Design of Experiments) Has Used to Derive Simple Mathematical Relationships for Determining the Effects of Geometric Parameters of Joint Strength. The Validity of the Failure Criterion Has Been assessed By Comparing with Experimental Data from Tests Conducted on the Single-Lap Joints.

• MEANING OF MISSING BOLT

Bolt are automatically loosened and Leave their original Position Either Due to Vibration in Machine or Corrosion Due to atmosphere.

Also Due to Damage During Working Period, Some Bolts May Get Deflected.

Thus Whole System of Bolt Connection May Miss Some Bolts Due to above Reason.

This Type of System is Called MISSING BOLT SYSTEM.

This Phenomenon is Dangerous For Bolt Connection Because Whenever the Connection Loses any One Bolt then total Strength of Bolted Connection is Reduced and Sometimes Connection May Fail……

II. MODELLING AND ANALYSIS

A. MANUAL CALCULATION

If It Is Not Required That a Joint Be Slip-Critical, then the Design Issues are the Shear Capacity of the Bolts and the Bearing Capacity of the Connected Material. The Effect of Joint Length upon Bolt Shear Strength. The Subject of Bearing In the Connected Material Will Be Presented.

• Bolt Shear Capacity

$V_r = 0.60 \times \phi_b \times n \times m \times a_b \times Fu$

Where V_r = Factored Shear Resistance
n = Number of Bolts
m = Number of Shear Planes
ϕ_b = Resistance Factor, Taken as 0.80
Fu = Specified Ultimate Tensile Strength
A_b = Cross-Sectional area of the Bolt Corresponding to the Nominal Diameter

It Was Noted That the Nominal Shear Strength of Bolts In Long Lap Splices Must Reflect the Effect of Joint Length. The S16 Standard Requires That When L≥15d, Where L Is the Joint Length (Between the Extreme Bolts) and d Is the Bolt Diameter That the Shear Strength Calculated and Reduced By the Factor 1.075-0.005 L/d, But Not Less Than 0.75.

In Many Cases, Especially Shorter Joints, Those are Unnecessarily Conservative. The Joint Length Reduction Factor Is Intended to apply Only to Lap Splices. The Joint Length Phenomenon Does Not applies to the Bolts in Web Framing angels, For Example. The Value Selected for the Resistance Factor for Bolts in Shear, ϕ_b =0.80, Is appropriate.

a) Original Bolt Miss Model Calculation

$Br = 2.5\, K_b\, t\, d\, n\, Fu / \gamma_{mb}$

$Fu = B_r \gamma_{mb} / 2.5\, k_b\, t\, d\, n$

Where:- Br=400 KN
Kb = 0.56
Thickness = 16mm
Diameter = 16mmϕ
No of Bolt = Five
Fu = (400000)1.25 / (2.5×0.56×16×16×5)
= 279.0178 N/mm^2

b) First Bolt Miss Model Calculation

$Br = 2.5\, K_b\, t\, d\, n\, Fu / \gamma_{mb}$

$Fu = B_r \gamma_{mb} / 2.5\, k_b\, t\, d\, n$

Where: - Br=330 KN
Kb =0.58
Thickness=16mm
Diameter=16mmϕ
No of Bolt=Four
Fu = (330000)1.25 / (2.5×0.58×16×16×4
= 277.8151 N/mm^2

c) Second Model Calculation

$Br = 2.5\, K_b\, t\, d\, n\, Fu / \gamma_{mb}$

$Fu = B_r \gamma_{mb} / 2.5\, k_b\, t\, d\, n$

Where: - Br=332.6 KN
Kb = 0.56
Thickness =16mm
Diameter =16mmϕ
No of Bolt =Four
Fu = (332600) 1.25/ (2.5×0.56×16×16×4)
= 290.0041 N/mm^2

d) Middle Bolt Miss Model Calculation

$Br=2.5\ K_b\ t\ d\ n\ Fu\ /\ \gamma_{mb}$

$Fu=B_r\gamma_{mb}\ /2.5\ k_b\ t\ d\ n$

Where: - Br=319.7 KN

Kb =0.56

Thickness=16mm

Diameter=16mmϕ

No of Bolt= Four

Fu= (319700)1.25 / (2.5×0.56×16×16×4)

= 278.7562 N/mm^2

e) Forth Bolt Miss Model Calculation

$Br=2.5\ K_b\ t\ d\ n\ Fu\ /\ \gamma_{mb}$

$Fu=B_r\gamma_{mb}\ /2.5\ k_b\ t\ d\ n$

Where: - Br=332.7 KN

Kb =0.56

Thickness = 16mm

Diameter= 16mmϕ

No of Bolt= Four

Fu = (332700)1.25 / (2.5×0.56×16×16×4)

= 290.0913 N/mm^2

f) Fifth Bolt Miss Model Calculation

$Br=2.5\ K_b\ t\ d\ n\ Fu\ /\ \gamma_{mb}$

$Fu=B_r\gamma_{mb}\ /2.5\ k_b\ t\ d\ n$

Where: - Br=330.1 KN

Kb =0.58

Thickness= 16mm

Diameter= 16mmϕ

No of Bolt= Four

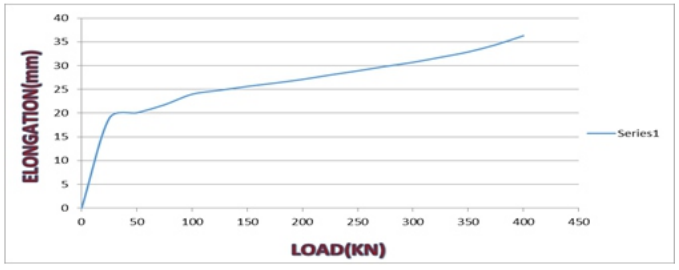
Fu = (330100)1.25 / (2.5×0.58×16×16×4)

= 277.8993 N/mm^2

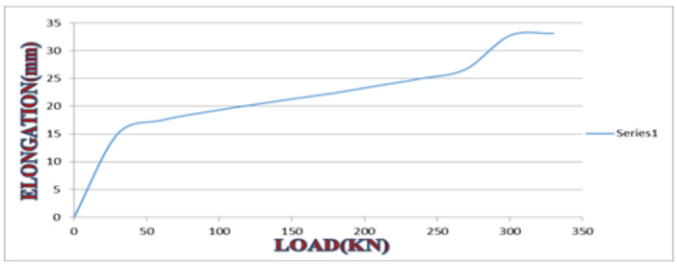
A. EXPERIMRNTAL PROCESS

Whenever any Results Is to be achieved, the Role of the Process Is Very Important. The aim of the Work Was to Find out Behaviours of the Joint, Find out the Change in Stress Distribution and Find out the Effect of Missing Blot to the Other Blot. For the Experimental Process the Block of alloy Steel Fe410 Was Selected as the aim was to compare the Software and Experimental Results.

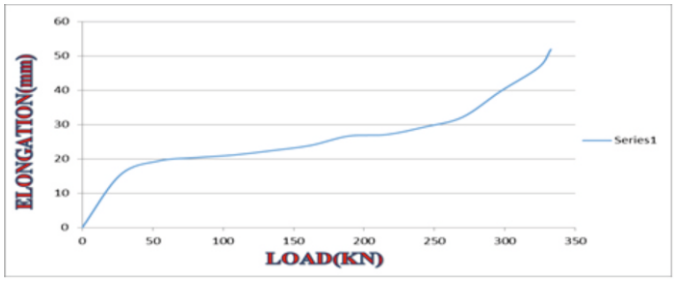
a) Original Bolt Connection



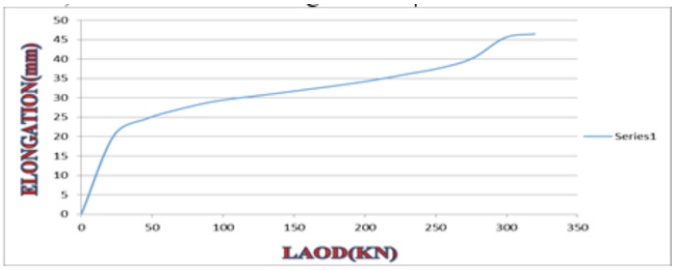
b) First Bolt Missing Connection



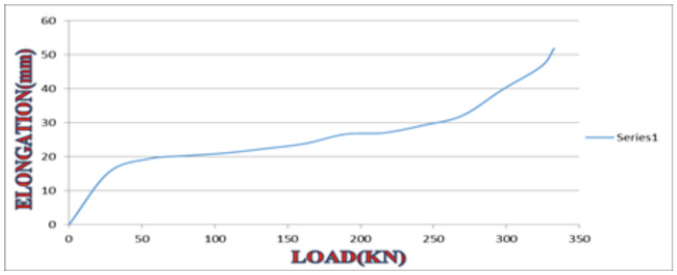
c) Second Bolt Missing Connection



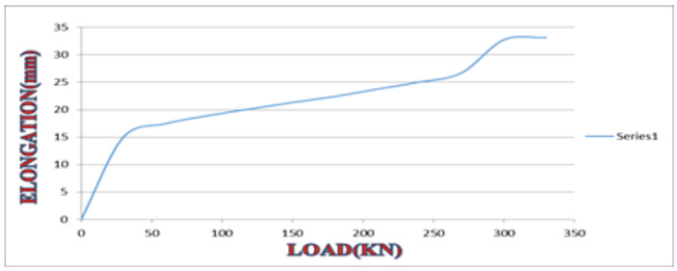
d) Middle Bolt Missing Connection



e) Forth Bolt Missing Connection



f) Fifth Bolt Missing Connection

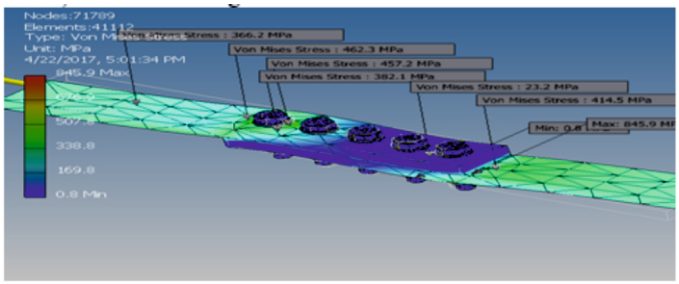


C. SOFTWARE

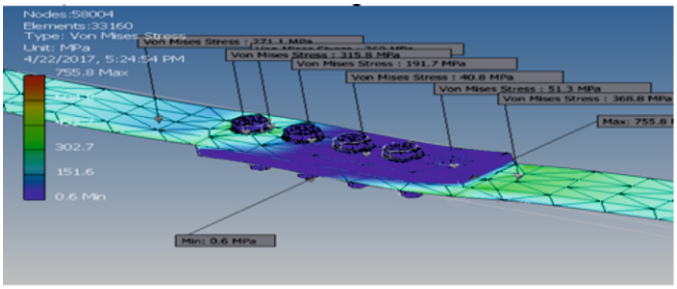
The finite element model prepared after practical testing and analysis of these model by the help of the SOLIDWORK SOFTWARE. Those model analyse with the help of the SOLIDWORK SOFTWARE.

In these thesis test on original (6-bolts are there), fist bolt missing, second bolt missing, middle bolt missing, forth bolt missing and fifth bolt missing is carried out. In these models without original model another model affected by the missing bolt system.

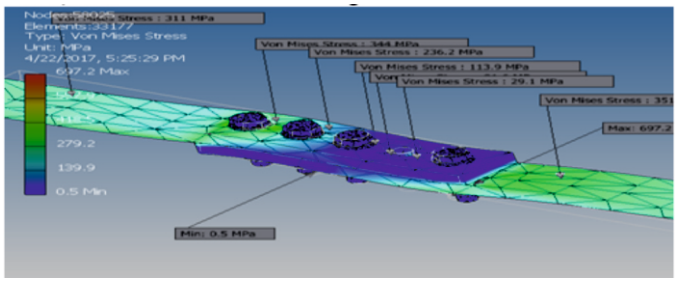
a) Stress of Original Model



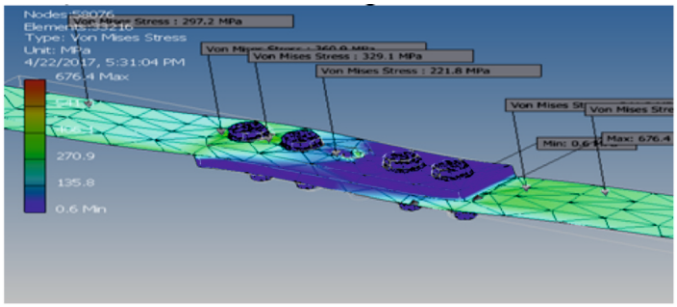
b) Stress of 1st Bolt Missing Model



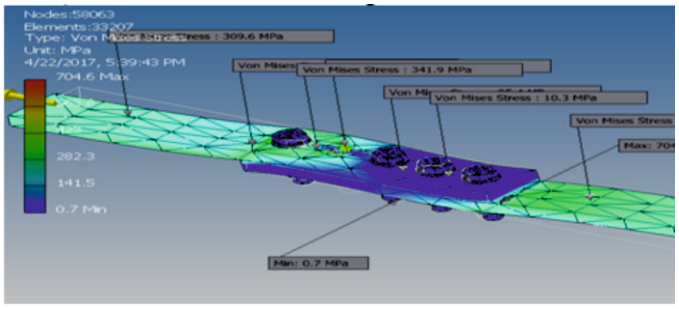
c) Stress of 2nd Bolt Missing Model



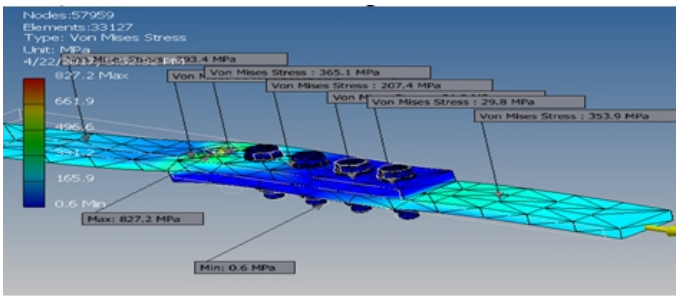
d) Stress of 3rd Bolt Missing Model



e) Stress of 4th Bolt Missing Model



f) Stress of 5th Bolt Missing Model



III. CONCLUSIONS

- Missing of One Bolt in the connection reduced the Strength Nearer 16.85% to 20.07%.
- Strength of the Connection Depends Upon the Stress Distribution around the Bolt Hole. Stress Distribution is more around the Hole and When the Bolt Was Missed, the Strength of Connection get Reduced. This Phenomenon Was Use full, Which Gave the Idea about the Bolt Importance.
- Hear in Bolted Connection E/D and W/D Ratio was Respectively 1.67 and 1.80.
- Strength of the Connection Was Depending On the Clearance Between Bolt and Hole. More the Clearance Than Connection Reduces and Less Clearance, Connection Strength Increase.
- Due to above reason in order to achieve no clearance, 8.8 grades M16 bolt was tightened by the nut with torque range. Torque range was fitted by the 135 N.m. torques.
- Comparison Study

Analysis	Manually Calculation Stress (N/mm^2)	Practical Calculation Stress (N/mm^2)	Software Calculation Stress (N/mm^2)
Original Bolts Connection	279.0178	384.6153	335.8665
First Bolts Missing	277.8151	317.3076	274.2013
Second Bolts Missing	290.0041	319.8076	280.7658
Middle Bolts Missing	278.7562	307.4038	268.9400
Forth Bolts Missing	290.0913	319.9076	280.8594
Fifth Bolts Missing	277.8993	317.4038	274.0215

IV. FUTURE WORK

Further research is needed in the following aspect of the stainless steel encased concrete column structure

- This tensile test was analyzed for static load. In future it can be analyzed for other load.
- Comparison of type of failures, behavior of joint and prediction factor can be carried out for other types of loading.
- Finding of optimum bolt patterns is vital to the final performance of the structure.

II. REFERENCES

1. Chakrabarti, S.K. and Bjorhovde, R. (1983) Tests of Full Size Gusset Plate Connections. Department of Civil Engineering the University Of Arizon.
2. Epstein, H. I. and Chamarajanagar, R. (1994) Finite Element Studies For Correlation With Block Shear Tests. Computers and Structures, Vol. 61, No. 5 pp. 967-974.
3. Hardash, S. G., and Bjorhovde, R. (1984) Gusset Plate Design Utilizing Block-Shear Concepts, The Department Of Civil Engineering.
4. Hibbit, kaelsson and Sorenson Inc. (1987) "ABAQUS/Standard." Theory Manual, Version 5.8, Pawtucket, R.I.
5. Fisher, J.W., Galambos, T.V., Kulak, G.L, Ravindra and M.K., "Load and Resistance Factor Design Criteria for Connection," J. of the Structural Division, ASCE, Vol. 104, No.ST9, September 1978.
6. Bibliography on Bolted Joints, ASCE Manuals And Reports On Engineering Practice, No. 48, American Society Of Civil Engineers, Reston, VA.,
7. G.L. Kulak, J.W. Fisher, And J.A.H. Struik, Guide To Design Criteria For Bolted And Riveted Joints, Second Edition, John Wiley, New York, 1987.
8. C. Batho and E.H. Bateman, "Investigations On Blots And Bolted Joint, Second Report Of The Steel Structures Research Committee," London, 1934.